A Comparison between Early and Late Tracheostomy in Critically Ill Patients

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Abstract

Background and Objectives: Tracheostomy is one of the most common procedures performed in intensive care units. Timing of tracheostomy on an intubated critically ill patient has been very controversial. Recommendations range from performing a tracheostomy after just 3 days to more than 21 days after translaryngeal intubation due to the risk of mucosal damage to the larynx and vocal cords. This study aims to compare between critically ill patients outcome after either early tracheostomy (ET) (10 days) or late tracheostomy (LT) (10 days).

Study Design: This is a non-randomized single-center cohort study that was prospectively conducted on 60 critically ill mechanically ventilated patients, scheduled for tracheostomies between January 2010 to January 2011. Patients were divided into two groups; group A: 30 patients who underwent LT and group B: 30 patients underwent ET. All the demographic, intra-operative and postoperative data were prospectively collected and analyzed statistically.

Results: There was no significant difference between both groups concerning the baseline demographic data, the ICU admission diagnosis, co-morbidities and intra-operative complications. However, but early post-operative complications were significantly higher in the LT group compared to the ET group. The duration of ICU stay, mechanical ventilation, and mortality were significantly higher in the LT compared to the ET group.

Conclusion: There was a higher incidence of early post-operative complications and mortality in the LT group compared to the ET group in critically ill patients in Egypt. Hence, we suggest ET for the management of mechanically ventilated critically ill patients who are indicated for prolonged mechanical ventilation.

Key Words: Tracheostomy — Critical care — Mortality — Intensive care unit.

Introduction

WITH advances in critical care medicine over the past 30 years; more patients are surviving initial episodes of acute respiratory failure, trauma, and extensive surgeries and are requiring prolonged periods of mechanical ventilation. It is now common practice to expeditiously convert these patients from translaryngeal intubation to tracheostomy. Relative to translaryngeal intubation, tracheostomy potentially affords greater patient comfort, more effective pulmonary toilet, increased airway security, and less airway resistance [2].

Among patients with appropriate anatomy, tracheostomy can be safely performed at bedside using a percutaneous technique [3]. The timing of when to perform tracheostomy continues to be individualized, it should include daily weaning assessment. Bedside techniques are safe and efficient, allowing timely tracheostomy with low morbidity [4]. The decision to proceed to tracheostomy is often made only if the patient could not be extubated within 10-14 days or more [5].

For those with anticipated need for artificial airway for more than 21 days, tracheostomy is recommended. For all other patients, the decision regarding the timing of tracheostomy is left to daily assessment and physician preference [6].

Despite the common use of tracheostomy for patients requiring prolonged mechanical ventilation, there are still several fundamental unanswered questions concerning this procedure. These questions include when during the course of mechanical ventilation should a tracheostomy be performed? And what are the benefits in terms of patient outcomes associated with timing of tracheostomy? So

Abbreviations:
ET = Early tracheostomy.
LT = Late tracheostomy.
ICU = Intensive care unit.
our Aim in this study is to compare the ET (10 days) and the LT (10 days) regarding the outcome and complications, in critically ill patients.

Patients and Methods

This is a prospective non-randomized study conducted on sixty critically ill ventilated patients who underwent tracheostomy at the Critical Care Medicine Dept., at Cairo University Hospitals, Egypt in the period from January 2010 to January 2011. Study was approved by Cairo University Hospital’s Ethics Committee.

The eligibility criteria included all translaryngeally intubated mechanically ventilated patients, requiring further ventilation, airway control or pulmonary toilet. Excluded from the study were patients with infection of tracheostomy site, known or expected difficult endotracheal intubation, distorted anatomy with unidentifiable anatomic landmarks, previous surgery at the site, bleeding diathesis and those with unstable cervical spine. The Patients were assigned into two groups:

• Group A: Thirty patients who underwent LT.
• Group B: Thirty patients who underwent ET.

For every patient the following data were collected:
- Personal history, clinical examination, presence of co-morbid conditions, duration of translaryngeal intubation (days).
- Investigations as ABG, Chest X-ray, Hb level, Mean Arterial blood pressure (before and after tracheostomy).
- Intra and post-operative complications: Bleeding, hypoxia, hypotension, pneumothorax, surgical emphysema, false passage, inability to complete the procedure, procedural mortality, wound infection and atelectasis.
- The duration of ICU stay (days).
- The duration of mechanical ventilation (days).
- The number of patients who were successfully weaned from mechanical ventilation after tracheostomy.

Surgical techniques and procedure:

Anticoagulation was discontinued at least 12 hour before the procedure or after correction of coagulopathy when indicated. Patients were placed on a regimen of 1.0 FIO2, and analgesia, sedation and relaxation were administered (midazolam, fentanyl and pancuronium intravenously). The neck was hyperextended (unless the patient requires cervical spine precautions) and antiseptic solution on the surgical field was administered. All patients were monitored for ECG, respiratory rate, arterial blood pressure and pulse oximetry [7].

The tracheostomy was done using either the standard surgical technique [8,9] or the percutaneous dilatational technique [10] using the Ciaglia multiple dilator kit (Ciaglia Percutaneous Tracheostomy).

The following definitions were used for various complications: [1]
- **Bleeding**: A drop in hematocrit level to below 3 gm%.
- **Hypotension**: Mean arterial pressure <60mmHg.
- **Hypoxia**: Lowering of SaO2 during the procedure (<90%) or PaO2 of < 60 Mmhg with FIO2 of 0.4.
- **Procedural mortality**: Mortality directly related to technique complication, during the procedure or later during stay in the ICU.

Data analysis:

All data were collected prospectively. Categorical data are displayed as percentages. Continuous data are reported as mean±SD. Comparisons were performed with an unpaired t-test for continuous, normally distributed data. Comparisons between categorical variables were performed with Chi-square X² test. P<0.05 was considered as significant. SPSS (version 13) software was used for data analysis.

Results

Baseline demographic characteristics were homogenous in the two groups of patients without statistical significant difference regarding number, age, sex, the median APACHE II score on admission and the history of chronic health disease (Table 1).

**Diagnosis on admission:**

There was no significant difference between both groups regarding the diagnosis on ICU admission (Table 2).

**Indications for tracheostomy:**

There was no significant difference between both groups regarding patients conditions at performance of tracheostomy (Table 3).

**The intra and post-operative complications in both groups:**

In the present study there was no statistically significant difference between both groups regarding intra-operative complications of tracheostomy but the rate of complications in the early postoperative period (within one week) was significantly higher in the LT group compared to the ET group:
surgical emphysema 5 patients (16.7%) vs none (p=0.052), pneumothorax 2 patients (6.7%) vs none (p=0.492), hypoxia 5 patients (16.7%) vs none (p=0.052), wound infection 7 patients (23.3%) vs 1 patient (3.3%) (p=0.053), minimal bleeding 5 patients (16.7%) vs 1 patient 3.3% (p=0.195), significant bleeding 3 patients (10.3%) vs none (p=0.293), postoperative hypotension 3 patients (10.3%) vs none (p=0.293), and postoperative collapse 3 patients (10.3%) vs none (p=0.293) in the LT group compared to the ET group.

The mean duration of mechanical ventilation (days) was significantly higher in the LT group compared to the ET group (24.77±2.71 vs 11.67±1.63) (p-value of 0.0001). The mean duration of ICU stay in the ET group (18.07±2.57) was significantly shorter than that of the LT group (30.67±2.80) (p<0.001). The mean duration of endotracheal intubation (ETT) was significantly longer in LT compared to the ET group (20.77±2.11 days vs 9.33±1.30 days) (p-value <0.001).

Chest-X ray before and immediately after tracheostomy showed no pneumothorax or surgical emphysema in either groups, 4 patients with ARDS in the LT group compared to 5 patients in the ET group, 12 patients with patches of infection in LT group compared to 13 patients in ET group, 5 patients with atelectasis in the LT group compared to 4 patients in the ET group, 2 patients with pleural effusion in the LT group compared to 3 patients in the ET group.

After performing tracheostomy, there were 2 patients with pneumothorax in the LT group compared to none in the ET group, 5 patients with surgical emphysema in the LT group compared to none in the ET group, 3 newatelectasis after tracheostomy in the LT group compared to none in the ET group.

The study end point was either survival or weaning from mechanical ventilation as (Table 4) shows.

Table (1): Baseline demographic and co-morbidities characteristics of both groups.

<table>
<thead>
<tr>
<th></th>
<th>LT</th>
<th>ET</th>
<th>Test of sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Age (years) median</td>
<td>54</td>
<td>52</td>
<td>Z=0.400</td>
</tr>
<tr>
<td>(range)</td>
<td>(22-76)</td>
<td>(23-72)</td>
<td>p=0.689</td>
</tr>
<tr>
<td>Sex (n) male/female</td>
<td>N=17</td>
<td>N=11</td>
<td>FEp=2.411</td>
</tr>
<tr>
<td></td>
<td>(56.7)/</td>
<td>(36.7)/</td>
<td>p=0.121</td>
</tr>
<tr>
<td></td>
<td>N=13</td>
<td>N=19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(43.3)</td>
<td>(63.3)</td>
<td></td>
</tr>
<tr>
<td>APACHE II score</td>
<td>28.0</td>
<td>27.0</td>
<td>1.371</td>
</tr>
<tr>
<td>median (range)</td>
<td>(23.0-30.0)</td>
<td>(24.0-30.0)</td>
<td>(0.170)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>N=5</td>
<td>N=5</td>
<td>FEp=1.000</td>
</tr>
<tr>
<td></td>
<td>16.7%</td>
<td>16.7%</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>N=6</td>
<td>N=7</td>
<td>FEp=0.098</td>
</tr>
<tr>
<td></td>
<td>20.0%</td>
<td>23.3%</td>
<td>p=0.754</td>
</tr>
<tr>
<td>Ischemic heart Disease</td>
<td>N=7</td>
<td>N=4</td>
<td>FEp=0.506</td>
</tr>
<tr>
<td></td>
<td>23.3%</td>
<td>13.3%</td>
<td></td>
</tr>
<tr>
<td>Chronic renal impairment</td>
<td>N=3</td>
<td>N=5</td>
<td>FEp=0.706</td>
</tr>
<tr>
<td></td>
<td>10.0%</td>
<td>16.7%</td>
<td></td>
</tr>
<tr>
<td>COPD</td>
<td>N=2</td>
<td>N=1</td>
<td>FEp=1.000</td>
</tr>
<tr>
<td></td>
<td>6.7%</td>
<td>3.3%</td>
<td></td>
</tr>
<tr>
<td>Hepatic patients</td>
<td>N=1</td>
<td>N=2</td>
<td>FEp=1.000</td>
</tr>
<tr>
<td></td>
<td>3.3%</td>
<td>3.3%</td>
<td></td>
</tr>
</tbody>
</table>

APACHE II : Acute Physiology and Chronic Health Evaluation.  
NS : Not significant.  
Z : Z for Mann Whitney test.  
X² : Chi square test.  
P : Statistically significant at p.<.005.  
FEp : Chi square test.  
FEp : p-value for Fisher Exact test.
Table (2): Diagnosis on intensive care unit admission.

<table>
<thead>
<tr>
<th></th>
<th>LT N=30</th>
<th>ET N=30</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.  %</td>
<td>No.  %</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>10 33.3</td>
<td>12 40.0</td>
</tr>
<tr>
<td>Cancer patient (Complicated)</td>
<td>3 10.0</td>
<td>3 10.0</td>
</tr>
<tr>
<td>Post-cardiac arrest</td>
<td>2 6.7</td>
<td>3 10.0</td>
</tr>
<tr>
<td>Post operative</td>
<td>2 6.7</td>
<td>2 6.7</td>
</tr>
<tr>
<td>Decompansated heart failure</td>
<td>4 13.3</td>
<td>3 10.0</td>
</tr>
<tr>
<td>Respiratory failure (all types)</td>
<td>6 20.0</td>
<td>5 16.7</td>
</tr>
<tr>
<td>Renal failure</td>
<td>1 3.3</td>
<td>1 3.3</td>
</tr>
<tr>
<td>Neuromuscular disease</td>
<td>2 6.7</td>
<td>1 3.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30 100.0</td>
<td>30 100.0</td>
</tr>
<tr>
<td><strong>MCp</strong></td>
<td>0.995</td>
<td></td>
</tr>
</tbody>
</table>

Table (3): Conditions at performance of tracheostomy.

<table>
<thead>
<tr>
<th></th>
<th>LT N=30</th>
<th>ET N=30</th>
<th>MCp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.  %</td>
<td>No.  %</td>
<td></td>
</tr>
<tr>
<td>Hypoxic brain damage with coma</td>
<td>2 6.7</td>
<td>4 13.3</td>
<td></td>
</tr>
<tr>
<td>Sepsis with multi-organ failure (MOF)</td>
<td>6 20.0</td>
<td>5 16.7</td>
<td></td>
</tr>
<tr>
<td>Upper airway obstruction (e.g tumor...)</td>
<td>3 10.0</td>
<td>0 0.0</td>
<td></td>
</tr>
<tr>
<td>Chronic obstructive lung disease</td>
<td>2 6.7</td>
<td>1 3.3</td>
<td>0.474</td>
</tr>
<tr>
<td>Acute respiratory distress syndrome</td>
<td>4 13.3</td>
<td>5 16.7</td>
<td></td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>10 33.3</td>
<td>8 26.7</td>
<td></td>
</tr>
<tr>
<td>Difficult weaning from MV*</td>
<td>3 10.0</td>
<td>7 23.3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30 100.0</td>
<td>30 100.0</td>
<td></td>
</tr>
</tbody>
</table>

V* : Mechanical ventilation.
MCp: P for Monte Carlo test.
* : Statistically significant at p<0.05.

**Discussion**

Our study included 60 patients admitted to the units of critical care at Cairo University (30 patients in each group) and the study was designed to compare the effect of timing of tracheostomy on the length of ICU stay, duration of mechanical ventilation, weaning from mechanical ventilation and mortality in both early and late tracheostomy groups (ET, LT).

In our study, the baseline demographic characteristics, diagnosis on Intensive Care Unit (ICU) admission, indications of tracheostomy, co-morbidities and the mean APACHEII score were homogenous between both groups without statistical significant difference.

The LT group had the following complications; 3 patients had clinically significant bleeding and required blood transfusion, 5 patients had a minimal bleeding, 5 patients had surgical emphysema which resolved spontaneously, 2 patients with pneumothorax which had been resolved following chest tube drainage, 3 patients had atelectasis of one or both lungs, 5 patients were hypoxic and 7 patients were hypotensive.

Our study showed that early tracheostomy had a favorable impact on the outcome of critically ill patients in terms of reduction of mechanical ventilation days, length of ICU stay, and mortality in the ET group compared to the LT group where mean duration of translaryngeal intubation before tracheostomy in ET group i.e (timing of tracheostomy) (10±2) was significantly shorter than that in the surgical group (22±4). Many reports are consistent with our results and favour early tracheostomy:

Teoh et al. 1111 found that patients with blunt, multiple organ trauma have a shorter duration of mechanical ventilation, fewer episodes of nosocomial pneumonia, and a significant reduction in hospital costs when the tracheostomy is performed within 1 week of their injuries. Similar benefits have been reported in patients with head trauma and poor Glasgow Coma Score, and patients with thermal injury, if a tracheostomy is performed within a week after the injury.

Rumbark et al. [12] conducted a randomized trial compared (ET) (less than 48 hours) to (LT) (14 to 16 days) in 122 medical patients. They found that the early group had significantly decreased mortality (31.7 versus 61.7 percent), nosocomial pneumonia (5 versus 25 percent), length of ICU stay (4.8 versus 16.2 days), and duration of mechanical ventilation (7.6 versus 17.4 days).

In a meta-analysis of five studies (406 patients), including the aforementioned trial, Griffiths et al. [13] found that early tracheostomy (less than seven days) was associated with a shorter duration of mechanical ventilation and a shorter length of ICU stay.

Scales et al. [14], conducted a retrospective cohort study of more than 10,000 patients who underwent tracheostomy compared those who underwent early tracheostomy (10 days) to those who underwent late tracheostomy (>10 days) showed that early tracheostomy group had better outcome.
In our study, the mean duration of mechanical ventilation in the ET group (12±3) was significantly shorter than that of the LT group (25±5). This was comparable to many reports, Rumbark et al. [12] found that the early group had significantly decreased the duration of mechanical ventilation (7.6 versus 17.4 days).

Consistent to our study Griffiths et al. [13] found that early tracheostomy (less than seven days) was associated with a shorter duration of mechanical ventilation; The combined results showed duration of artificial ventilation was significantly lower in the early tracheostomy group (weighted mean difference -8.5 days, 95% confidence interval -15.3 days to -1.7 days, p=0.03). Similarly Scales et al. [14] found that patients who had early tracheostomy had more ventilator-free days.

In agreement with our study, Zagli et al. [15] found that Among 506 patients who underwent tracheostomy, 250 and 250 patients were retrospectively assigned to the early tracheostomy (ET) or late tracheostomy (LT) group. They found that early tracheostomy was associated with significantly reduction in length of MV (21±19 vs 29±17 days, p=0.02). Many other reports support these findings [16-18].

In our study, the mean duration of ICU stay in the ET group (20±5) was significantly shorter than that of the LT group (30±5). This was comparable to many reports; Rumbark et al. [12] found that the early group duration of ICU stay (4.8 versus 16.2 days).

Consistent to our study Griffiths et al. [13] found that the length of stay in the ICU was significantly lower in the early tracheostomy group (6.1 versus 15.3 days, p=0.001). Similarly Marcus et al. [19], compared outcomes in 147 patients who had undergone a bedside tracheotomy. In 20 cases, the procedure was performed less than seven days after intubation. The rest 127 received tracheotomy seven or more days later. They found that early tracheotomy can significantly shorten a patient’s length of ICU stay.

In agreement with our study Ahmed and John [20] conducted a retrospective study over 55 patients admitted to the surgical ICU with severe traumatic brain injury 27 patients underwent early tracheostomy <7 days and 28 patients underwent late tracheostomy days. They found that the early group had a significantly shorter stay in the ICU than patients in the late group (19.0±7.7 vs. 25.8±11.8 days; p=0.008).

Consistent with our results, Zagli et al. [15] found that early tracheostomy was associated with significantly shorter duration of ICU compared with late tracheostomy (33±22 vs 42±18 days, p=0.042; p<0.0001).

In the present study, the mortality in the ET group (16 patients) (54%) was lower than the LT group (25 patients) (83%). This was in agreement with many reports; Rumbark et al. [12] reported that the early tracheostomy was associated with decreased mortality (31.7 versus 61.7 percent). Similarly Scales et al. [14] noticed a significant reduction in 90-day mortality (34.8 versus 36.9 percent), one-year mortality (46.5 versus 49.8 percent), and study mortality (63.9 versus 67.2 percent) when tracheostomy was done early.

Many other reports support our finding [16-18].

On the other hand there are also many recent reports that argue against early tracheostomy:

According to research presented at the American Thoracic Society's annual meeting in New Orleans May 2010, Trouillet et al. [21] found that, in a selected population of patients requiring prolonged MV after cardiac surgery, early tracheostomy provided no benefit in terms of MV duration, hospital length of stay, mortality or incidence of infectious complications compared to prolonged intubation possibly followed by late tracheostomy.

Similarly, Ahmed and John [20] studied the impact of early tracheostomy (7 days) on mortality in patients with blunt chest trauma. They found that; there was no significant association between mortality and timing of the tracheostomy.

Again Marcus et al. [22] conducted a retrospective study, compared outcomes in 147 patients who had undergone a bedside tracheotomy while on mechanical ventilation. In 20 cases, the procedure was performed <7 days after intubation. The rest (127) received the tracheotomy seven days. They found that early tracheotomy did not appear to reduce mortality.

On the other hand Heffner et al. [23] recommendations take into account the very low mortality and morbidity associated with placing a tracheostomy, plus the advantages and disadvantages of both translaryngeal intubation and tracheostomy. In summary, if a patient remains ventilator dependent after a week of translaryngeal intubation, tracheostomy can be considered.
Durbin et al. [23] recently found that the substantial heterogeneity and study design limitations of the available literature prohibit its application to all patients. Their meta-analysis attempted to control for these effects. Durbin et al. [23] found lower overall mortality with early tracheostomy. In addition, no reports suggest worse outcome with early tracheostomy. Based on the current data, Durbin et al. [23] found that it is reasonable to perform early tracheostomy in all patients who will require prolonged mechanical ventilation. Unfortunately, identifying these patients is difficult. This may be due to lack of prediction tools for many patient populations. King et al. [24] suggested that patients with neuromuscular causes for respiratory failure, severe head injury, burn, or upper-airway obstruction are more easily identified as candidates for early tracheostomy.

In our study, the number of patients who were successfully weaned from mechanical ventilation (MV) was significantly higher in the ET group compared to the LT group (12 vs. 3), p<0.015.

This was in agreement with Gatti et al. [25] who conducted prospective analysis over 33 patients to determine the predictors of weaning from MV after cardiac operation. The early group was performed after a mean time of 7.7±5.0 consecutive days of translaryngeal intubation.

Twenty-four (73%) patients were weaned from ventilator after a mean time of 15.8±9.1 days. Time point of tracheostomy was the only predictor of ventilator weaning (p=0.0029): There was significant association between ET performed before the seventh day of translaryngeal intubation and successful weaning from MV).

Many other reports were consistent with our results [6,15,16].

In contrast to our results, there were other reports found that there was no difference in the outcome (weaning from MV, duration of MV, duration of ICU stay and mortality) between patients who underwent early tracheostomy compared to those who underwent late tracheostomy [19-21].

Conclusions:

- The early application of tracheostomy is associated with a better outcome in critically ill patients in term of reduction of ICU stay, Mechanical ventilation days and mortality.
- The optimal time of performing tracheostomy is still controversial, and recommendations ranging from 3 days up to 21 days after translaryngeal intubation, however we recommend if the patients expected to be intubated more than 7 days early tracheostomy should be considered.
- The early application of tracheostomy facilitate the weaning from MV in critically ill patients.

References